course W and W' might be so related that this would be true, but in general they are not. To see at which point there is limiting friction, we might proceed as follows: Solve on the supposition that limiting friction exists between sphere and box, and not between sphere and wall; then solve with the opposite assumption; one of these results will be found smaller than the other, I think it is the latter; we infer then that limiting friction must exist at wall and not at box, and hence that the latter result is the correct one. W. H. DRANE.

88. Proposed by ALOIS F. KOVARIK, Instructor in Mathematics, Decorah Institute, Decorah, Ia.

Show that the equation to the trajectory is

$$y = x\tan\alpha - \frac{gx^2}{2v^2\cos^2\alpha},$$

and that v and a can be varied at pleasure, the projectile can in general be made to traverse any two given points in the same vertical plane with the point of projection. [Ex. 83, page 244, Deschanel's *Natural Philosophy*, Part I.]

Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Mathematics and Science, Chester High School, Chester, Pa.; WALTER H. DRANE, Graduate Student, Harvard University, Cambridge, Mass.; B. F. SINE, Principal of Normal School, Rock Enon Bridge, W. Va.; ELMER SCHUYLER, Reading, Pa.; and the PROPOSER.

Let v=velocity of projection, α=angle of elevation, t=time, (x, y) the coordinates of the point in its path at the time t.

$\therefore$ $x = vt\cos\alpha$=horizontal motion. $y = vt\sin\alpha - \frac{1}{2}gt^2$=vertical motion.

Eliminating t, we get at once,

$$y = x\tan\alpha - \frac{gx^2}{2v^2\cos^2\alpha} \quad \ldots\ldots (1).$$

(1) is true no matter what be the values of v and α.

Let (m, n), (b, c) be the coördinates of two points. Then from (1) we get

$$n = m\tan\alpha - \frac{gm^2}{2v^2\cos^2\alpha}, \qquad c = b\tan\alpha - \frac{gb^2}{2v^2\cos^2\alpha}.$$

$$\therefore\ \alpha = \tan^{-1}\left(\frac{nb^2 - m^2c}{mb^2 - m^2b}\right), \qquad v^2 = \frac{g[(mb^2 - m^2b)^2 + (nb^2 - m^2c)^2]}{2(mb^2 - m^2b)(bn - mc)}.$$

These values of α and v will cause the trajectory to pass through the two given points.

89. Proposed by GUY B. COLLIER, Schenectady, N. Y.

Assuming that the Northern Pacific R. R. tracks between Fargo and Bismark(North Dakota) to lie on the 47th parallel of latitude; also that the Limited Express weighs 300 tons, and that a speed of 60 miles per hour is maintained between the two places · find the difference between the vertical pressures on the rails of the Express east and the express west.